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PROVISIONAL STANDARDS OF RADIATION
SAFETY DURING FLIGHTS

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1. Introductory Section

1.1. Purpose

These standards for radiation safety cover all radiation factors which under space flight conditions can affect the crew of a manned aircraft of any purpose.

1.2. Terms and Definitions

1.2.1. Radiation safety is the collective property of the spacecraft, body and means for ensuring the flight to resist the comprehensive effect of all radiation factors which result in a reduction in the efficiency of the participants in the space flight, as well as in the appearance of adverse effects after its completion.

1.2.2. System for ensuring radiation safety is the set of engineering, technical and medical methods, resources and measures implemented at all stages of planning and creating the manned spacecraft and during as well as after the completion of the flight which are directed towards ensuring radiation safety.

1.2.3. Standard level of radiation is the amount of the equivalent radiation dose during the space flight which in light of the current ideas does not lead to a reduction in the efficiency of the space flight participants which is of significant effect for fulfilling the flight program nor to the appearance of adverse effects after its completion.

1.2.3.1. Equivalent of radiation dose is the product of an absorbed dose in the given point of tissue for the quality coefficient.

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Note. For the purposes of radiation protection during space flights it is permitted to use as a unit for the equivalent of the dose "rem" and the dependence of the quality coefficient on the linear transmission of energy recommended by the "Standards of Radiation Safety".

1.2.3.2. Reliability of protection of manned aircraft is the probability of not exceeding the standard level of radiation under conditions of the given

*Numbers in margin indicate pagination in original foreign text.

flight.

1.2.4. Appraisal of radiation safety is the set of measures directed towards establishing a correspondence between the expected levels of radiation effect beyond protection of the manned aircraft under the standard conditions of its operation and the standard levels for the given duration of the flight and towards establishing a correspondence to the requirements for the reliability of this protection.

2. Brief Characterization of Radiation Effects during Space Flights

2.1. Main Sources of Radiation Danger

The main sources of radiation danger during space flights are emissions of radiation zones of the earth, solar corpuscular and galactic space radiation, ionizing emissions of spaceborne radioisotopic, energy and motor units. The radiation effect in outer space depends on the program of the planned space flight, the design of the spacecraft, the arrangement of the manned compartments, etc.

2.2. Peculiarities of Radiation Effects during Space Flights

The peculiarities of the radiation effects during space flights are governed both by the physical characteristics of radiation and by the specific conditions of the space flight, the peculiarities of the craft's design, etc. The main ones are the complex composition of space radiation (protons, electrons, highly charged ions, etc.), the broad energy spectrum of these emissions, the space-time variation in the radiation currents, formation of secondary emissions in the protection and tissue, uneven distribution of absorbed doses of radiation on the body surface and in it, the high values for effective coefficients of 15 radiation quality, the final probability for exceeding the standard level of radiation beyond protection which is governed by the stochastic nature of the

flashes of solar corpuscular radiation, the combined effect of radiation and other factors of the space flight, etc.

3. Main Radiobiological Prerequisites for the Basis of Standard Levels of Radiation during Space Flights

3.1. General Principles for Basis

3.1.1. Manned space flights belong to the type of activity with the highest overall risk level.

3.1.2. Space flights occur under conditions of possible adverse effect from many factors, including radiation.

3.1.3. The successful implementation of the space flight program is determined by the condition of preserving the efficiency of the vehicle in the assigned limits.

3.1.4. The system for ensuring safety is designed to preserve the health and life of the participants of space flights and limit the risk of adverse delayed aftereffects.

3.1.5. With consideration for the total number of participants in the space flights genetic effects in the future from the action of radiation are essentially excluded.

3.2. Initial Radiobiological Prerequisites

3.2.1. With a total **dose of standard** radiation 70-100rad and strength of dose less than 20 rad per year doses are not reached which promote the formation of clinically expressed manifestations of radiation sickness even in the most vulnerable organs and systems.

3.2.2. With total doses of standard radiation on the order of 100-150 rad and strength of dose 20-50 rad per year in 20-30% of the individuals effaced manifestations of the sickness can occur. The periods for the formation of the

syndrome extend to 2-5 years from the start of exposure. The symptoms of radiation damage are weakly expressed.

3.2.3. With total doses of standard radiation over 150-400 rad and strength of dose over 100 rad per year the clinical syndrome of chronic radiation sickness involving the majority of the organs and systems develops in 80-90% of the individuals. The formation of the syndrome occurs in the first 1-2 years. Disorders requiring hospitalization according to clinical indications are very limited and are found in single cases.

3.3. Main Sources of Radiobiological Data for Basis of Standard Levels

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3.3.1. Clinical materials for exposure of people under occupational conditions and during clinical use of radiation therapy.

3.3.2. Materials of comprehensive "Chronic Experiment" conducted on 240 dogs irradiated over 3-6 years under conditions simulating the radiation situation in lengthy space flights.

3.3.3. Materials of observations of testers in a comprehensive experiment in a model interplanetary spacecraft with simulated effect of galactic space and solar corpuscular radiation.

3.3.4. Materials from studies of the biological action of protons and highly charged ions on accelerators of charged particles.

3.3.5. Data of radiobiological studies on artificial earth satellites of the series "Zond" (No. 5-8) and "Kosmos" (No. 110, 368, 605, 690 and others), manned craft and stations.

3.3.6. Data of ground radiobiological studies to evaluate the combined action of radiation and other factors of the space flight, studies of effective doses, etc.

3.3.7. Materials of the ICRP [International Commission of Radiation Protection].

3.3.8. Materials of the Radiobiological Section of the Committee on Space Medicine, the National Academy of Sciences, National Research Council and the USA National Aeronautics and Space Administration.

4. Standard Levels of Radiation during Space Flights

4.1. Standard Levels Depending on Duration of Space Flight

4.1.1. For the planned calculations of protection for the bodies of manned spacecraft the following standard levels of radiation (SIR) have been set depending on the duration of space flight (T):

T, months	SIR, rem for flight	T, months	SIR, rem for flight
1	50	6	110
2	65	8	125
3	80	10	140
4	90	12	150
5	100		

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Note: 4.1.1.1. The cited values for the standard level refer to the uniform overall irradiation or to the effect on the bone marrow whose effective depth of occurrence is taken in the calculations of protection as equal to 5 cm of tissue.

4.1.1.2. For other organs of the body the following multipliers have been set: skin--3, crystalline lens of eye--1.5, sex glands--0.5. These coefficients are used in case of uneven irradiation of the body.

4.1.1.3. For flights lasting less than 1 month the standards are maintained which were confirmed by the USSR Ministry of Public Health in 1966.

4.1.1.4. For the intermediate values of the duration of flight T linear interpolation is permitted according to the nearest values of the standard level.

4.1.1.5. The maximum permissible dose (MPD) of uniform overall irradiation of the entire body or irradiation of the bone marrow due to the effect of any types of ionizing emissions, including irradiation during x-ray and other medical examinations of cosmonauts using radiation is set at 400 rem during the 5 years of their occupational activity.

4.2. Limitation of Single Effect of Radiation

A single effect from any sources of radiation during space flights is

limited by the level 50 rem. The interval between repeated effects in the same dose should not be less than 1 month. The total dose for the flight then must not exceed the standard levels of radiation set in section 4.1.1.

4.3. Requirements for Reliability of Protection

The requirements for the reliability of the protection from radiation during space flights are set depending on the purpose of the manned spacecraft, however in all cases the reliability of the protection, determined in accordance with section 1.2.3.2., must not be lower than 0.99 with confidence probability 0.80 at the stage of technical proposals and 0.90 at the stage of technical design.

5. Concluding Section

5.1. Date of Introduction

These standards for radiation safety during space flights are introduced from 9/1/1975.

5.2. Date of Effectiveness

These standards for radiation safety are introduced for a period of effectiveness from 9/1/1975 to 9/1/1978 with subsequent replacement for permanent standards.